United States
Department of
Agriculture

Forest Service

**Intermountain
Research Station**

General Technical
Report INT-241

February 1988

Density and Biomass of Trout and Char in Western Streams

William S. Platts
Michael L. McHenry

THE AUTHORS

WILLIAM S. PLATTS is a research fishery biologist for the Intermountain Research Station in Boise, ID. He received a B.S. degree in conservation education in 1955 from Idaho State University, and an M.S. degree in fisheries in 1957 and a Ph.D. degree in fisheries in 1972 from Utah State University. From 1962 to 1966, he worked as a regional fishery biologist and supervisor in enforcement with the Idaho Fish and Game Department. From 1966 through 1976, he was the Idaho zone fishery biologist for the Intermountain Region, Forest Service, U.S. Department of Agriculture, and consultant to the Surface Environment and Mining (SEAM) program. He has been in his present position since 1976.

MICHAEL L. MCHENRY, is a biological technician with the Intermountain Research Station in Boise, ID. He received a B.S. degree in fisheries from Humboldt State University in 1983 and an M.S. in fisheries from New Mexico State University in 1986. He has been employed with the Station since 1985.

ACKNOWLEDGMENTS

We would like to thank a number of people who freely contributed data, without which this study would not have been possible. Eric Gerstung, John Dienstadt, and Dennis McEwan of the Wild Trout Project (California Fish and Game) provided the majority of the data for the Sierra Nevada region. Similarly, Don Duff and Gene Weller provided data from the Great Basin States of Utah and Nevada, respectively. Jack Van Deventer provided invaluable statistical consultation and volunteered much of his own time to develop predictive curves. Clifford Hawkes and John Rinne provided technical and critical review of the manuscript.

Intermountain Research Station
324 25th Street
Ogden, UT 84401

Density and Biomass of Trout and Char in Western Streams

William S. Platts
Michael L. McHenry

INTRODUCTION

The protection and health of aquatic ecosystems has received increasing attention during the last two decades. Public concern and activism during the 1960's and 1970's led to congressional mandates such as the National Environmental Policy Act (NEPA) of 1969. This act requires agencies of the Federal government to identify the potential environmental effects of any development to be addressed in Environmental Impact Statements (EIS) and Environmental Impact Reports (EIR). Other legislative acts, such as the Federal Land Policy and Management Act of 1976, mandate the Bureau of Land Management, U.S. Department of the Interior, to inventory the resources of the 473 million acres under its jurisdiction and call for comprehensive land use planning. Similarly, the Forest Service, U.S. Department of Agriculture, through the National Forest Management Act (1976), has been directed to develop on each of 156 National Forests an inventory of all resources and their respective condition culminating in long-term management plans that respond to public concerns and management issues. Biological populations, including native and exotic fisheries, are a critical element of these planning processes. In an era of complex multiple-use conflicts, knowledge of resources is of paramount importance. This report presents inventory data on a regional perspective that will assist land-use planning and management requirements concerning fish populations as outlined under Federal law.

A fish population is shaped by the geologic, chemical, physical, and biological factors within and surrounding the environment in which it lives. The relative quality of that environment affects the organisms living there, exerting positive or negative pressure on the population. A relatively simple and inexpensive method of evaluating the health of lentic systems is to monitor the density and biomass of the fish population. Because lower trophic levels are difficult, costly, and often time consuming to monitor, surveys of fish populations may be used to provide an overall measure of ecosystem health. The size, structure, and growth rates of fish populations allow determination of habitat condition, as well as inferences about lower trophic levels.

Fishery biologists are routinely requested to evaluate the physical and biotic potential of aquatic habitats, or the effects of various land uses such as logging, grazing, mining, and hydroelectric power development on these habitats. Stream surveys are often designed to evaluate the quality of lentic habitats, which in the Western United States are dominated geographically by economically important trout and char of the genera *Salmo* and *Salvelinus*. Evaluation of a particular fisheries resource typically involves the measures of the species population characteristics.

Important measures of a stream's health and productivity are the density, biomass, and species composition of fishes in a given stream. Once these measures are obtained, a biologist must know how a particular stream compares to other streams of similar condition. A comparison of the biomass/density of similar species from different geographical regions is often difficult because the literature is usually incomplete. Most data concerning trout density and biomass are scattered, found mainly in obscure State publications ("gray literature") that rarely are distributed or indexed. As a result, biologists often make comparisons between their particular population and trout/char populations in New Zealand, Denmark, or Scotland, where such data have been commonly published and indexed. Unfortunately, such comparisons are not only misleading but perhaps meaningless. This paper represents the first compilation of trout population characteristics in the Western United States.

The primary purpose of this publication is to help bridge this data gap by presenting density and biomass information from a variety of stream habitats representative of lentic ecosystems in the 11 Western States. Aquatic resource managers can use these data as an aid when considering fish population needs during planning and management.

The following fish species are discussed in this publication:

Common name	Scientific name
Apache (Arizona) trout	*Salmo apache*
Atlantic salmon	*Salmo salar*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Bull trout	*Salvelinus confluentus*
Cutthroat trout	*Salmo clarki* spp.
Gila trout	*Salmo gilae*
Golden trout	*Salmo aquabonita*
Rainbow trout	*Salmo gairdneri*

METHODS

Density and biomass of salmonids in western streams were obtained from a variety of stream habitats, either directly through the research of the authors, by personal communication with fishery specialists, or from the literature. Although some large streams were included in the analysis, the emphasis was upon smaller streams (less than 8 m width), where evaluation techniques are usually more effective and accurate. We made an effort to obtain a comprehensive data base, but some geographic gaps are

evident. We were unable to locate extensive fish population data in northern Arizona, eastern Washington, northern New Mexico, and southern Nevada, where, we conclude, extensive surveys of trout populations are nonexistent or poorly documented.

Trout density and biomass are listed in numbers per square meter (fish/m^2) and grams per square meter (g/m^2), respectively, except where stream surface area was unavailable. In those instances, values were listed as numbers or grams per linear meter (fish/m, g/m). When data from several stream stations or time-series data were available, a range of high and low values and arithmetic means are provided. If only one station was sampled, the value is listed singly under the range column and a dash was entered in the arithmetic mean column.

Many of the data points were obtained from studies concerning the effects of various land uses (such as logging, mining, grazing) upon trout populations. In these instances only data from control sections were used. Thus, the density and biomass levels presented here mainly reflect levels that might be found in pristine or lightly altered stream systems. We also avoided streams that were heavily stocked with livestock.

The vast majority of trout population data was obtained by electrofishing techniques. However, the accuracy of reported estimates was difficult to determine because measures of statistical precision were rarely reported.

Figure 1—Geographic ecoregions of the Western United States, adapted from Bailey (1980): Pacific Forest, Sierra Nevada Forest, Columbia Forest, Intermountain Sagebrush, Rocky Mountain Forest, Colorado Plateau, and Upper Gila Mountains.

Geographic Region

Because State boundaries do not delineate various land surface forms, and because we wanted to provide for geographic consistency, we grouped streams by ecoregion following the classification of Bailey (1980). Some minor changes were made in Bailey's provinces to better reflect drainage patterns. A province or ecoregion was defined as a geographic area delineated by differences in geologic landform and climates as expressed by broad vegetation patterns. Analysis by ecoregion allows interregional comparisons with the assumption that the streams of concern are roughly similar in regards to geologic processes, climatic conditions, dominant vegetation, and landform. Thus, it may be possible to make meaningful comparisons. Trout/char density and biomass are given for seven ecoregions of the Western United States (fig. 1): Pacific Forest, Sierra Nevada Forest, Columbia River Forest, Intermountain Sagebrush, Rocky Mountain Forest, Colorado Plateau, and Upper Gila Mountain.

Statistical Analysis

Density and biomass of salmonids were grouped regionally and plotted by frequency of occurrence. Because of the skewed distribution of the data and apparent heterogeneity of the variance, medians of each region were calculated as well as other descriptive statistics. Box plots (Chambers and others 1983) were generated by region for both trout density and biomass. Box plots represent graphic summarizations of data but require some explanation. In the box plot, the upper 75th and lower 25th percentiles are represented by the top and bottom of the rectangle, respectively. Thus, the box illustrates the spread of the bulk of the data (the central 50 percent). The box plot allows a partial assessment of symmetry. If the distribution of the data is symmetrical, the median will divide the box into equal halves. The solid lines represent tails of the data distribution, while isolated circles are outlying data points.

To test for biomass differences between and among regions and individual species, we used one-way analysis of variance (ANOVA) and the Fisher's Least Significant Difference (LSD) test (Ott 1984) at the 0.05 percent significance level. Data analysis was analyzed on an IBM PC using the General Linear Model procedure of SAS (SAS Institute 1985).

We explored the relationship between trout biomass and density through least squares regression techniques (Sokal and Rohlf 1973) using biomass as the dependent variable. Data analysis was executed using the regression procedure of SAS (SAS Institute 1985).

Regional biomass curves were developed and plotted through least squares regression techniques and curve fitting routines using a Hewlett-Packard 9845 computer. It should be noted that neither the coefficient of determination nor the significance for these curves was reported. These curves represent planning aids and do not depict cause and effect relationships. Therefore, to prevent their misuse, formulas have been omitted.

RESULTS

We analyzed data from 313 streams in the Western United States for trends and significant differences. Biomass of salmonids in western streams exhibited tremendous variability, ranging from 0 to 81.9 g/m^2 (tables 1-7) and averaging 5.4 g/m^2 for all sites. Regionally, streams in the Gila Mountain region occupied by the endangered Gila and Arizona trouts had the highest mean biomass, averaging 9.1 g/m^2. Sierra Nevada Forest streams had the greatest range and the second highest average biomass (8.2 g/m^2), followed closely by streams of the Rocky Mountain Forest region (7.7 g/m^2) and Colorado Plateau (6.1 g/m^2). Trout streams of the Intermountain Sagebrush and Columbia River Forest ecoregions averaged 4.0 and 3.8 g/m^2, respectively. Streams within the Pacific Forest ecoregion exhibited the smallest range of values as well as the lowest mean biomass (table 8). Significant differences between regions were found at the 0.01 percent level (ANOVA $F = 4.80$). Results of the Fisher's LSD test depict the significant differences between individual ecoregions and are depicted in table 9. The Fisher's LSD test is a multiple comparison of the difference between paired means through Student's *t*-tests. For example, the first line in table 9 compares the biomass of trout in the Rocky Mountain region with trout in the Gila Mountain region. The table indicates that trout biomass of the Rocky Mountain region is 2.38 g/m^2 less than that of the Gila Mountain region. However, the difference was not significant at the 0.05 percent level. Confidence intervals (95 percent were then generated around the mean difference of the regions being tested.

Table 1—Density and standing crop biomass of salmonids in selected streams within the Pacific Forest ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Badger Creek, OR	Brook/Rainbow	(0.14 to 0.32)	0.22	(2.7 to 5.4)	4.5	USDA FS 1985
Barlow Creek, OR	Brook/Rainbow	(0.13 to 0.19)	.16	(1.3 to 3.0)	2.2	USDA FS 1985
Bear Creek, WA	Cutthroat	(0.13 to 0.42)	.30	(1.5 to 3.6)	2.4	June 1981
Boulder Creek, OR	Brook/Rainbow	(0.12 to 0.17)	.14	(2.5 to 2.8)	2.7	USDA FS 1985
Bonney Creek, OR	Brook/Rainbow	0.04	—	0.24	—	USDA FS 1985
Buck Creek, OR	Brook/Rainbow	0.08	—	0.91	—	USDA FS 1985
Bull Creek, WA	Cutthroat	(0.052 to 0.074)	.063	(1.1 to 1.4)	1.3	Martin and others 1981
Cane Creek, OR	Cutthroat	0.55	—	1.14	—	Murphy 1979
Caspar Creek, (N. Fk.), CA	Rainbow	—	—	(0.9 to 1.4)	1.2	Burns 1971
Christmas Creek, WA	Cutthroat	(0.15 to 0.39)	.26	(2.0 to 3.7)	2.7	USDA FS 1985
Clear Creek, OR	Brook/Rainbow	(0.10 to 0.16)	.12	(1.7 to 3.2)	2.4	USDA FS 1985
Cook Creek, OR	Cutthroat	0.97	—	0.75	—	Murphy 1979
Deer Creek, OR	Cutthroat	(0.32 to 0.39)	.34	—	4.6	Hall and Lantz 1969
Flynn Creek, OR	Cutthroat	(0.38 to 0.49)	.43	—	4.8	Hall and Lantz 1969
Forest Creek, OR	Brook/Rainbow	0.44	—	9.3	—	Hall and Lantz 1969
Gate Creek, OR	Brook/Rainbow	(0 to 0.19)	.09	(0 to 5.8)	1.8	Hall and Lantz 1969
Gate Creek, (S. Fk.), WA	Brook/Rainbow	0.07	—	1.5	—	Martin and others 1981
Godwood Creek, (N. Fk.), CA	Cutthroat/Rainbow	(0.09 to 0.18)	.10	(0.49 to 0.57)	0.53	Burns 1971
Greenback Creek, WA	Cutthroat	0.25	—	1.7	—	WDF 1984
Hadsell Creek, OR	Cutthroat	—	—	(4.8 to 5.5)	5.1	USDA FS 1985
Honor Camp Creek, WA	Cutthroat	(0.23 to 1.3)	.74	(1.8 to 4.8)	3.3	Osborn 1981
Hurst Creek, WA	Cutthroat	(0 to 0.02)	.009	(0 to 0.54)	0.24	Osborn 1981
Iron Creek, OR	Brook/Rainbow	0.13	—	3.9	—	USDA FS 1985
Jordan Creek, OR	Brook/Rainbow	(0.18 to 0.54)	.41	(5.7 to 10.7)	7.3	USDA FS 1985
Little Badger Creek, OR	Brook/Rainbow	(0 to 0.51)	.26	(0 to 3.7)	2.2	USDA FS 1985
Lewis River, (E. Fk.), WA	Cutthroat	0.3	—	(0.04 to 0.77)	0.4	WDF 1984
Lookout Creek, OR	Cutthroat	(0.11 to 0.40)	.25	(0.24 to 0.30)	0.27	Murphy 1979
Mack Creek, OR	Cutthroat	1.06	—	0.28	—	Murphy 1979
McKinely Creek, WA	Cutthroat	—	—	2.9	—	WDF 1984
McRae Creek, OR	Cutthroat	(0 to 0.54)	0.12	(0 to 0.56)	0.17	Murphy 1979
Mill Creek, OR	Cutthroat	1.1	—	1.4	—	Hall and Lantz 1969
Miller Creek, WA	Cutthroat	(0.004 to 0.07)	.04	(0.069 to 1.44)	2.3	WDF 1984
Miller Creek, (E. Fk.), WA	Cutthroat	(0 to 0.16)	.07	(0 to 2.9)	1.5	WDF 1984
Mineral Creek, OR	Brook/Rainbow	0.14	—	2.4	—	USDA FS 1985
Mona Creek, OR	Cutthroat	0.33	—	0.77	—	Murphy 1979
Needle Creek, OR	Cutthroat	(0.22 to 0.40)	.29	3.3	—	Hall and Lantz 1969
Octopus Creek, WA	Cutthroat	(0.47 to 1.8)	1.1	(3.9 to 7.7)	5.9	Osborn 1981
Rebel Creek, OR	Cutthroat	0.46	—	0.62	—	Murphy 1979
Rock Creek, WA	Cutthroat	—	—	0.09	—	WDF 1984
Shale Creek, WA	Cutthroat	(0.032 to 0.052)	.043	(0.78 to 1.1)	0.96	WDF 1984
Simmonds Creek, OR	Cutthroat	0.07	—	0.87	—	Murphy 1979
Slide Creek, WA	Cutthroat	—	—	0.02	—	Martin and others 1981
Snahapish River, (W. Fk.), WA	Cutthroat	(0.056 to 0.15)	.10	(1.6 to 3.7)	2.6	Osborn 1981
Solleks River, WA	Cutthroat	(0.026 to 0.056)	.046	(0.91 to 1.3)	1.0	WDF 1984
Stequaleho Creek, WA	Cutthroat	(0.013 to 0.047)	.036	(0.266 to 1.3)	1.0	Martin and others 1981
Stequaleho Creek, (E. Fk.), WA	Cutthroat	(0.15 to 0.56)	.31	(1.4 to 3.2)	2.1	Martin and others 1981
Stequaleho Creek, (W. Fk.), WA	Cutthroat	(0.13 to 0.54)	.31	(0.74 to 2.8)	1.9	Martin and others 1981
Sugar Creek, OR	Cutthroat	0.36	—	0.65	—	USDA FS 1985
Ten Williamette River Basin Tribs	Cutthroat	(0.25 to 2.51)	—	—	—	Nickelson and Hafele 1978
Thermos Creek, OR	Cutthroat	0.20	—	0.14	—	Murphy 1979
Threemile Creek, OR	Cutthroat	(0 to 0.8)	.46	(0 to 11.9)	6.3	USDA FS 1985
Tygh Creek, OR	Brook/Rainbow	(0 to 0.36)	.25	(0 to 5.3)	3.2	USDA FS 1985
Walker Creek, OR	Cutthroat	0.02	—	0.07	—	Murphy 1979
White River, OR	Brook/Rainbow	(0.03 to 0.06)	.04	(1.1 to 3.7)	1.9	USDA FS 1985
Wycoff Creek, OR	Cutthroat	0.33	—		—	Murphy 1979
Yaker Creek, (S. Fk.), CA	Rainbow	(0.71 to 1.05)	.9	(2.9 to 4.2)	3.5	Burns 1971

Table 2—Density and standing crop biomass of salmonids in selected streams within the Sierra Forest ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source[1]
		Fish/m²		*g/m²*		
Alder Creek, CA	Brown/Rainbow	(0.13 to 0.26)	0.19	(2.5 to 7.0)	4.7	
Bear Creek, CA	Brown/Rainbow	—	—	8.9	—	
Birch Creek, CA	Brook/Brown/Rainbow	(0.19 to 0.35)	.27	(10.3 to 15.3)	12.8	
Birch Creek, CA	Brook	0.03	—	3.8	—	
Bishop Creek, CA	Brown	(0.20 to 0.45)	.3	(8.6 to 15.2)	11.8	
N.Fk. Bishop Creek, CA	Brook/Brown/Rainbow	0.48	—	26.9	—	
S.Fk. Bishop Creek, CA	Brown/Rainbow	(0.21 to 0.62)	.36	(14.8 to 24.3)	18.2	
E.Fk. Carson River, CA	Rainbow/Brown/Cutthroat	(0.003 to 0.09)	.03	(0.3 to 2.3)	1.4	
W.Fk. Carson River, CA	Brook/Brown/Rainbow	(0.004 to 0.02)	.01	(0.4 to 1.9)	1.1	
Cold Stream, CA	Brook/Brown	0.07	—	2.8	—	
Coldwater Creek, CA	Rainbow	0.01	—	4.5	—	
Convict Creek, CA	Brown/Rainbow	(0.13 to 0.55)	.30	(7.2 to 17.7)	11.7	Needham and others 1945
Cosumnes River, CA (N. Fk.)	Rainbow/Brown	—	—	(3.0 to 11.6)	6.9	
Cottonwood Creek, CA	Golden	(0.15 to 0.25)	.20	(4.4 to 9.8)	7.6	
Deadman Creek, CA	Brook/Brown/Rainbow	(0.08 to 0.14)	.11	(2.3 to 2.4)	2.3	
Deer Creek, CA	Rainbow/Brown	(0.02 to 0.10)	.05	(2.9 to 13.4)	7.5	
Deer Creek, CA	Brook/Brown/Rainbow	0.18	—	4.7	—	
Dinkey Creek, CA	Brown/Rainbow	—	—	(5.4 to 5.9)	5.7	
Estroy Creek, CA	Rainbow/Brown	0.10	—	13.4	—	
Fall River, CA	Rainbow	0.004	—	14.0	—	
Forest Creek, CA	Rainbow/Brown	(0.03 to 0.07)	.05	(3.1 to 5.9)	4.6	
Glass Creek, CA	Brook	(0.4 to 0.5)	.45	(16.4 to 22.5)	19.4	
Greenhorn Creek, CA	Brown/Rainbow	0.02	—	3.1	—	
Horseshoe Meadow Creek, CA	Golden	0.61/m	—	8.4 g/m	—	
Horton Creek, CA	Brook/Brown/Rainbow	(0.13 to 0.29)	.19	(7.5 to 12.9)	9.9	
Hot Creek, CA	Brown/Rainbow	0.48	—	81.9	—	
Independence Creek, CA	Brook/Brown/Rainbow	(0.09 to 0.52)	.3	(7.8 to 15.5)	11.6	
Independence Creek, CA	Brown/Rainbow	0.07	—	2.2	—	
Juniper Creek, CA	Brook/Rainbow	0.09	—	2.9	—	
Kern River, CA	Brown/Rainbow	—	—	(0.6 to 6.0)	3.3	
Kern River, CA (South Fork)	Brown/Golden	—	—	(13.3 to 13.4)	13.3	
Kirkwood Creek, CA	Brook/Brown	(0.05 to 0.16)	.10	(4.8 to 10.2)	7.5	
Last Chance Creek, CA	Brown/Rainbow	(0.01 to 0.03)	.02	(1.3 to 9.5)	4.1	
Little Truckee R., CA	Brown/Rainbow	(0.007 to 0.19)	.05	(0.7 to 1.4)	1.3	
Lone Pine Creek, CA	Brown/Rainbow	(0.29 to 0.91)	.6	(3.9 to 4.9)	4.4	
Mammoth Creek, CA	Brown/Rainbow	(0.05 to 0.23)	.26	(8.8 to 38.4)	18.0	
Marble Fork, CA	Brown/Rainbow	—	—	(3.5 to 12.7)	6.5	
Martis Creek, CA	Brown/Cutthroat/Rainbow	(0.19 to 0.57)	.32	(8.3 to 11.6)	9.6	Moyle and Vondracek 1985
McGee Creek, CA	Brook/Brown	(0.47 to 0.67)	.57	(19.2 to 21.6)	20.4	
Merced River, CA	Brown/Rainbow	—	—	(0.8 to 4.5)	2.2	
South Fork Mokelumne River, CA	Rainbow/Brown	0.06	—	9.1	—	
North Fork Mokelumne River, CA	Rainbow/Brown	(0.01 to 0.06)	.02	(0.7 to 8.5)	3.4	
Mono Creek, CA	Brown	—	—	(4.0 to 8.9)	6.5	
North Fork Oak Creek, CA	Brown	0.06	—	2.0 g/m	—	
Olancha Creek, CA	Brown/Rainbow	0.1	5.4	—		
Oregon Creek, CA	Rainbow	(0.008 to 0.01)	.01	(0.9 to 2.6)	1.7	
Owens River, CA	Brown	(0.05 to 0.89)	.27	(1.5 to 82.9)	28.7	
Perazzo Creek, CA	Brook/Brown/Rainbow	0.08	—	5.8	—	
Pilot Creek, CA	Brown/Rainbow	0.008	—	1.8	—	
Pine Creek, CA	Brown/Rainbow	0.08	—	7.6	—	
Pleasant Valley Creek, CA	Rainbow/Brown	(0.01 to 0.02)	.015	(2.4 to 3.5)	2.9	
Pole Creek, CA	Cutthroat	0.04	—	2.6	—	
Poorman Creek, CA	Brown/Rainbow	0.04	—	10.8	—	
South Fork Prosser Creek, CA	Brown/Rainbow	0.01	—	1.1	—	
Red Clover Creek, CA	Brown/Rainbow	(0.02 to 0.02)	.02	(0.9 to 2.7)	1.8	
Red Lake Creek, CA	Brook/Rainbow	0.34	—	9.8	—	
Red Mountain Creek, CA	Brown	(0.34 to 0.56)	.45	(21.1 to 30.8)	25.9	
Rock Creek, CA	Brown	(0.007 to 0.29)	.07	(0.5 to 9.7)	1.8	
Rubicon Creek, CA	Brook/Brown/Rainbow	(0.005 to 0.08)	.04	(1.2 to 5.6)	3.4	
Sagehen Creek, CA	Brown/Rainbow	(0.03 to 0.11)	.07	(2.6 to 5.9)	4.2	
San Joaquin River, (S. Fk.), CA	Brown/Rainbow	—	—	(4.6 to 5.6)	5.1	
Shepherd Creek, CA	Brook/Brown/Rainbow	(0.02 to 0.21)	.09	(1.1 to 8.3)	4.3	
Silver Creek, CA	Brook/Brown/Rainbow	0.26	—	6.5	—	

(con.)

Table 2 (Con.)

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source[1]
		Fish/m²		*g/m²*		
Silver Creek, CA (S. Fk.)	Brown/Rainbow	(0.01 to 0.01)	.01	(1.1 to 1.2)	1.2	
Spratt Creek, CA	Rainbow	0.27	—	2.1	—	
Middle Fork Stanislaus River, CA	Brown/Rainbow	—	—	(0 to 13.4)	6.7	
Sutter Creek, CA	Rainbow/Brown	(0.02 to 0.03)	.02	(2.0 to 2.6)	2.3	
Taboose Creek, CA	Brown/Rainbow	(0.04 to 0.52)	.28	(2.0 to 11.5)	6.7	
Tinemaha Creek, CA	Brown/Rainbow	(0.08 to 0.39)	.23	(6.9 to 9.6)	7.9	
Trout Creek, CA	Rainbow	—	—	3.1	—	
Truckee River, CA	Brown/Rainbow	(0.008 to 0.04)	.02	(1.1 to 5.9)	2.8	
Tuttle Creek, CA	Brown/Rainbow	(0.49 to 0.50)	.49	(9.5 to 15.4)	12.4	
Weaver Creek, CA	Brown/Rainbow	0.05	—	5.7		
Wet Meadows Creek, CA	Golden	—	—	7.0		
Wolf Creek, CA	Brown/Rainbow/Brook	—	.03	(0.6 to 1.4)	1.0	

[1]Data provided by the California Department of Fish and Game, Wild Trout Project.

Table 3—Density and standing crop biomass of salmonids in selected streams within the Columbia Forest Province

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Bakeoven Creek, OR	Brook/Brown/Rainbow	0.71/m		23.3	—	USDA FS 1985
Beaver Creek, ID	Cutthroat	(0.05 to 0.1)	0.07	(1.0 to 2.3)	1.6	Rabe and others 1975
Big Creek, ID	Cutthroat/Brook	(0.02 to 0.21)	.15	—	—	Rabe and others 1975
Big Bear Creek, ID	Rainbow	(0 to 0.31)	.1	(0 to 4.5)	1.5	Johnson 1985
Big Boulder Creek, ID	Cutthroat/Rainbow	0.02	—	1.0	—	Rabe and others 1975
Big Lake Creek, ID	Cutthroat/Rainbow	0.04	—	2.3	—	Rabe and others 1975
Bond Creek, ID	Cutthroat/Brook	(0.09 to 0.27)	.15	—	—	Rabe and others 1975
Bruno Creek, ID	Cutthroat	0.01	—	2.7	—	Rabe and others 1975
Canal Gulch, ID	Brook	0.33	—	0.8	—	Johnson 1985
Cedar Creek, ID	Rainbow	0.36	—	1.5	—	Johnson 1985
Cellars Creek, ID	Cutthroat/Brown	(0.24 to 0.29)	.27	(11.1 to 13.8)	12.6	Rabe and others 1975
Clear Creek, ID	Cutthroat	(0 to 0.8)	.2	(0 to 6.5)	1.7	Johnson 1985
Clear Creek, ID (W. Fk.)	Cutthroat	0.33	—	5.2	—	Johnson 1985
Cow Creek, ID	Brook	0.01	—	0.2	—	Johnson 1985
Elk Creek, OR	Brook/Brown/Rainbow	0.04/m	—	2.9	—	
Garden Creek, ID	Cutthroat	(0.01 to 0.03)	.02	(1.1 to 1.9)	1.5	Rabe and others 1975
Horton Creek, ID	Brook	(0.03 to 0.12)	.085	(0.05 to 0.1)	.07	Authors
John Day River, OR (M. Fk.)	Mixed	0.1/m	—	5.3	—	
Johnson Creek, ID	Brook	(0.15 to 0.45)	.21	(2.2 to 5.6)	3.6	Authors
Kinnikinic Creek, ID	Cutthroat	(0.11 to 0.13)	.12	(5.4 to 7.8)	6.6	Rabe and others 1975
Lake Creek, ID	Rainbow	(0.13 to 0.20)	.11	(4.9 to 5.2)	5.1	Rabe and others 1975
Little Beaver Creek, ID	Brook	0.06	—	1.1	—	Johnson 1985
Little Boulder Creek, ID	Rainbow	2.5	—	6.4	—	Johnson 1985
Little Deschutes River, OR	Brown	—	—	(4.8 to 21.8)	9.4	
Lyon Creek, ID	Rainbow	0.04	—	1.0	—	Rabe and others 1975
Marble Creek, ID	Cutthroat	(0.01 to 0.17)	.07	—	—	Rabe and others 1975
Mica Creek, ID	Brook/Bull/Cutthroat	(0.03 to 0.23)	.09	—	—	Mauser 1972
Mill Creek, ID	Cutthroat	0.03	—	1.3	—	Rabe and others 1975
Orofino Creek, ID	Brook	(0 to 0.01)	.001	(0 to 0.42)	.06	Johnson 1985
Peavine Creek, OR	Brook/Brown/Cutthroat	0.1/m	—	14.6	—	USDA FS 1985
Pine Creek, OR	Brook/Brown/Cutthroat	0.006/m	—	2.8	—	USDA FS 1985
Pine Knob Creek, ID	Cutthroat	0.53	—	7.1	—	Johnson 1985
Poorman Creek, ID	Brook	0.15	—	1.0	—	Johnson 1985
Potlatch Creek, ID (N. Fk.)	Brook/Rainbow	(0.001 to 0.05)	.02	(0.06 to 1.5)	.6	Johnson 1985
Quartz Creek, ID	Cutthroat	(0.13 to 0.19)	.16	—	—	Johnson 1985
Red River, ID (N. Fk.)	Brook/Bull/Cutthroat/Rainbow	(0.03 to 0.05)	.04	(0.68 to 0.95)	.81	Authors
Red River, ID (S. Fk.)	Brook/Bull/Cutthroat/Rainbow	(0.02 to 0.03)	.02	(0.62 to 0.88)	.75	Authors
Reeds Creek, ID	Brook/Cutthroat	(0.28 to 0.40)	.33	—	—	
Road Creek, ID	Cutthroat	(0.02 to 0.06)	.03	(0.86 to 1.8)	1.4	Rabe and others 1975
Rochat Creek, ID	Brook/Cutthroat	(0.2 to 1.6/m)	1.0/m	—	4.7	Rabe and others 1975
Salmon River, ID (S. Fk.)	Bull	(0.09 to 0.66)	.26	(1.1 to 3.9)	2.5	Authors
Shanghai Creek, ID	Brook	0.91	—	7.9	—	Johnson 1985
Silvies River, OR	Brook/Brown/Rainbow	0.04/m	—	5.5	—	USDA FS 1985
Simmons Creek, ID	Bull/Cutthroat/Rainbow	(0.03 to 0.15)	.07	—	—	Rabe and others 1975
Squaw Creek, ID	Bull/Cutthroat/Rainbow	(0.01 to 0.02)	.01	(1.2 to 1.3)	1.2	Rabe and others 1975
Thompson Creek, ID	Bull/Cutthroat/Rainbow	(0.01 to 0.08)	.03	(0.3 to 5.2)	1.9	Rabe and others 1975
Trail Creek, ID	Brook	(0.05)	—	1.8	—	Johnson 1985
Trapper Creek, ID	Bull/Cutthroat	(0.15 to 0.22)	.18	(2.1 to 2.3)	2.2	Authors
Trout Creek, ID	Brook/Cutthroat	(0.03 to 0.72)	.27	—	—	Rabe and others 1975
Trout Creek, OR	Brook/Brown/Rainbow	0.5/m	—	4.0	—	USDA FS 1985

Table 4—Density and standing crop biomass of salmonids in selected streams within the Intermountain Sagebrush ecoregion (Great Basin)

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m^2		*g/m^2*		
Big Creek, UT	Brown/Cutthroat/Rainbow	(0.01 to 0.03)	0.018	(0.2 to 1.3)	0.8	Authors
Birch Creek, UT	Brook/Cutthroat	0.17	—	6.5	—	UDNR 1980
Boyd Creek, NV	Rainbow	0.49	—	1.0	—	NDOW 1980
Brown Creek, NV	Brook	0.11	—	2.9	—	NDOW 1980
Camp Creek, NV	Rainbow	(0.01 to 0.18)	.09	—	—	NDOW 1980
Care Creek, NV	Brook	0.11	—	0.1	—	NDOW 1980
Chimney Creek, NV	Humboldt Cutthroat	(0.06 to 0.6)	.34	(1.9 to 3.2)	2.2	Authors
Conners Creek, NV	Lahontan Cutthroat	(0.11 to 0.26)	.18	—	—	NDOW 1980
Cottonwood Creek, NV	Rainbow	(0.01 to 0.25)	.08	12.2	—	Authors
Cutt Creek, NV	Lahontan Cutthroat	(0.07 to 10.8)	3.6	—	—	NDOW 1980
Deep Creek, NV	Rainbow	0.19	—	2.2	—	NDOW 1980
Deer Creek, NV	Brook	(0.008 to 0.21)	.09	—	—	NDOW 1980
Draw Creek, NV	Lahontan Cutthroat	(0.25 to 1.7)	.76	—	—	NDOW 1980
Dunn Creek, UT	Rainbow	0.12	—	4.1	—	UDNR 1980
Fisher Creek, UT	Rainbow	0.39	—	8.0	—	UDNR 1980
Gance Creek, NV	Humboldt Cutthroat	(0.02 to 0.10)	.06	(4.2 to 13.6)	8.9	Authors
Jack Creek, NV	Brook/Rainbow	0.38	—	5.4	—	NDOW 1980
Kelley Creek, NV	Brook/Rainbow	0.35	–	4.8	—	NDOW 1980
Kendall Creek, ID	Brook/Cutthroat	1.02	-	—	—	Neve and Moore 1983
Marys River, NV	Lahontan Cutthroat	(0.001 to 0.02)	07	—	—	NDOW 1980
Mitchell Creek, NV	Cutthroat	0.21	·	12.7	—	NDOW 1980
Murphy Creek, NV	Brook	0.09	—	1.2	—	NDOW 1980
North Fork Humboldt River, NV	Brook/Cutthroat	0.06	—	2.2	—	NDOW 1980
North Fork Pratt Creek, NV	Brook	0.03	—	0.5	—	NDOW 1980
Pratt Creek, NV	Brook	0.02	—	0.7	—	NDOW 1980
Rattlesnake Creek, NV	Brook/Cutthroat	0.12	—	3.3	—	NDOW 1980
Sage Creek, ID	Brown	0.7	—	—	—	Heimer 1979
Sage Creek, ID (M. Fk.)	Brown	(0 to 0.15)	.075	—	—	Heimer 1979
Sage Creek, ID (N. Fk.)	Brook/Cutthroat	(0.11 to 0.46)	.21	—	—	Heimer 1979
Sage Creek, ID (S. Fk.)	Brown/Cutthroat/Rainbow	(0.32 to 0.36)	.34	—	—	Heimer 1979
Salmon Falls Creek, NV	Rainbow	(0.002 to 0.04)	.02	—	—	NDOW 1980
Smokey Creek, ID	Brook/Cutthroat	0.57	—	—	—	Heimer 1979
Spring Creek, ID	Brook/Cutthroat	(0.66 to 4.78)	2.3	—	—	Neve and Moore 1983
Sun Creek, NV	Rainbow	(0 to 0.62)	.18	—	—	NDOW 1980
Tabor Creek, NV	Rainbow	(0.5 to 0.63)	.23	—	—	Authors
Thomas Creek, NV	Brook	0.02	—	0.3	—	NDOW 1980
Toe Jam Creek, NV	Cutthroat	0.19	—	7.6	—	NDOW 1980
Waterpipe Canyon, NV	Rainbow	0.21	—	1.1	—	NDOW 1980
Wildcat Creek, NV	Lahontan Cutthroat	0.95	—	—	—	NDOW 1980

Table 5—Density and standing crop biomass of salmonids in selected streams within the Rocky Mountain Forest ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Archuleta Creek, CO	Brook/Brown	—		(12 to 20)	16.0	CDOW 1981
Beaver Creek, WY	Brook	—	—	3.4	—	Binns and Eiserman 1979
Bitter Creek, UT	Brook	0.16	—	10.5	—	UDNR 1980
Carnero Creek, CO	Cutthroat	—	—	(5.9 to 6.5)	6.7	CDOW 1981
Coal Creek, CO	Brook	(0.98 to 1.3)	1.1	(1.0 to 2.9)	1.9	Binns and Eiserman 1979
Coantag Creek, WY	Brown/Cutthroat	0.3	—	7.9	—	Remmick 1983
Cochetopa Creek, CO	Brown	(0.019 to 0.065)	—	(0.3 to 1.0)	—	CDOW 1981
Conejos River, CO	Brown	—	—	(4.0 to 10.0)	—	Nehring 1979
Como Creek, CO	Greenback Cutthroat	0.4	—	(0.15 to 6.6)	4.1	Anonymous
Cucharas Creek, CO	Mixed	—	—	19.1	—	CDOW 1981
Cunningham Creek, CO	Brook	—	—	4.4	—	CDOW 1981
Deadman Creek, WY	Bear River Cutthroat	0.04	—	0.89	—	Remmick 1983
Deadcow Creek, WY	Cutthroat	—	—	2.0	—	Binns and Eiserman 1979
Deer Creek, WY	Brown/Rainbow	—	—	5.3	—	Wesche 1980
Douglas Creek, WY	Brown	(2.3 to 9.4)	4.2	(2.6 to 9.1)	5.4	Wesche 1980
East River, CO	Mixed	—	—	11.3	—	Nehring 1983
Encampment River, WY	Brown	(0.6 to 1.6)	1.0/m	(2.3 to 8.5)	5.5	Wesche 1980
Frying Pan Creek, CO	Rainbow	(0.02 to 0.07)	—	(0.2 to 1.0)	—	CDOW 1981
Giraffe Creek, WY	Bonneville Cutthroat	(0.1 to 0.2/m)	.16/m	(2.2 to 4.4)	3.5	Binns and Eiserman 1979
Green River, WY	Brown/Rainbow	—	—	(1.9 to 6.6)	—	Wesche 1980
Gunnison River, Lake Fork, CO	Mixed	—	—	9.1	—	CDOW 1981
Green Timber Creek, WY	Cutthroat	—	—	2.2	—	Binns and Eiserman 1979
Hams Fork River, WY	Brown/Rainbow	—	—	4.4	—	Binns and Eiserman 1979
Harrison Creek, WY	Cutthroat	—	—	2.8	—	Binns and Eiserman 1979
Hog Park Creek, WY	Brown	(0.32 to 0.63/m)	.53/m	—	—	Wesche 1980
Huerfano River, CO	Mixed	—	—	6.2	—	CDOW 1981
Laramie River, WY	Brown	(0.24 to 0.61/m)	.45/m	(5.1 to 14.0)	10.5	Wesche 1980
Lead Creek, WY	Brook/Cutthroat	0.2/m	—	—	—	Remmick 1983
Little Green Creek, CO	Colorado River Cutthroat	(0.10 to 0.35)	.17/m	(3.86 to 3.96)	3.91	Scarnecchia and Bergeson 1986
Little Laramie River, WY	Brown	(0.4 to 1.0/m)	.71/m	(5.9 to 21.2)	13.5	Wesche 1980
Little PopoAgie River, WY	Brown/Rainbow	—	—	4.25	—	Binns and Eiserman 1979
Little Prickly Pear Creek, MT	Mixed	(0.03 to 0.26/m)	.14/m	(4.5 to 25.3)	15.4	Holton 1953
Little South Fork Cache la Poudre River, CO	Mixed	—	—	5.36	—	Nehring 1983
Los Pinos Creek, CO	Brook	(0.13 to 0.31)	—	—	—	CDOW 1981
Maki Creek, WY	Colorado River Cutthroat	0.04/m	—	1.2	—	Remmick 1983
Middle Fork Flathead Tribs., MT	Westslope Cutthroat/ Bull Trout	0.27/m	—	—	—	Leathe 1980
Nash Fork Creek, WY	Cutthroat	—	—	7.8	—	Binns and Eiserman 1979
North Fork Flathead Tribs., MT	Westslope Cutthroat/ Bull Trout	0.24/m	—	—	—	Leathe 1980
North Horse Creek, WY	Cutthroat	0.03/m	—	0.56	—	Remmick 1983
North Platte River, WY	Brown/Rainbow	—	—	5.8	—	Wesche 1980
Nylander Creek, WY	Brook/Colorado River Cutthroat	(0.02 to 0.4/m)	—	15.3	—	Remmick 1983
Paint Creek, WY	Brown/Rainbow	—	—	1.0	—	Remmick 1983
Poker Hollow Creek, WY	Brown/Rainbow/ Brook/Cutthroat	0.1	—	0.5	—	Remmick 1983
Prickly Pear Creek, MT	Brook/Brown/Rainbow	—	—	—	—	Elser 1968
Rabbit Creek, WY	Cutthroat	—	—	1.4	—	Binns and Eiserman 1979
Raymond Creek, WY	Brook/Cutthroat	—	—	11.0	—	Binns and Eiserman 1979
Right Hand Fork, CO	Greenback Cutthroat	(0.07 to 0.28)	.18/m	(8.94 to 11.13)	10.0	Scarnecchia and Bergeson 1986
Roaring Creek, CO	Greenback Cutthroat	(0.21 to 0.32)	.27/m	(7.46 to 7.91)	7.7	Scarnecchia and Bergeson 1986
Roaring Fork of the Little Snake, WY	Brook	(0.57 to 0.98)	.75/m	12.7	—	Wesche 1980
Rock Creek, WY	Brook/Brown/Rainbow	0.03	—	24.3	—	Remmick 1983
Rose Creek, WY	Cutthroat	—	—	5.6	—	Binns and Eiserman 1979
Sand Creek, WY	Rainbow/Brown	—	—	63.4	—	Binns and Eiserman 1979

(con.)

Table 5 (Con.)

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Sangre de Cristo River, CO	Cutthroat	—	—	(2.6 to 3.0)	2.8	Nehring 1979
Sheep Creek, MT	Rainbow	—	—	4.5	—	Leathe 1980
South Fork Rio Grande, CO	Brown/Rainbow	—	—	(11.4 to 13.0)	12.2	Nehring 1979
South Platte River, CO	Brown/Rainbow	(0.08 to 0.26)	0.18	(0.01 to 7.8)	2.8	Nehring 1979
South Platte River, CO (M. Fk.)	Brown/Rainbow	(>0.10)	—	(10.0 to 20.0)	—	Nehring 1979
St. Louis Creek, CO	Brook/Rainbow	—	—	(1.5 to 3.1)	2.3	Nehring 1983
St. Regis River, MT	Brook/Cutthroat	—	—	2.0	—	Leathe 1980
Sweetwater River, WY	Brown/Rainbow	—	—	3.2	—	Wesche 1980
Taylor Creek, CO	Brown	(1.5 to 3.7/m)	2.4/m	—	—	CDOW 1981
Tenmile Creek, CO	Brook/Rainbow	(0.012 to 0.078/m)	.056/m	(1.6 to 10.5)	5.8	CDOW 1981
Tongue River, WY	Cutthroat/Rainbow	—	—	8.8	—	Binns and Eiserman 1979
Trout Creek, CO	Brook/Brown	(0.01 to 0.04)	.02	(1.2 to 14.3)	5.6	CDOW 1981
Trout Creek, MT	Rainbow	—	—	(6.6 to 37.9)	13.5	Leathe 1980
West Branch of the North Fork of the Little Snake, WY	Cutthroat	(0.20 to 0.39/m)	.27/m	(3.4 to 5.9)	4.6	Wesche 1980
Williams Fork River, CO	Brook/Rainbow	—	—	(0.05 to 0.2)	0.1	Nehring 1979
Willow Creek, UT	Brook/Cutthroat/ Rainbow	0.17	—	10.6	—	UDNR 1980
Wind River, WY (E. Fk.)	Cutthroat	—	—	5.7	—	Wesche 1980

Density values listed as #/m, are included as surface area within study areas was not given, only linear distances.

Table 6—Density and standing crop biomass of salmonids in selected streams within the Colorado Plateau ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Beaver Creek, UT	Rainbow	(0.08 to 0.09)	0.085	(10.6 to 11.7)	11.1	UDNR 1980
Beaver Dam Wash, UT	Rainbow	(0.13 to 0.18)	.16	(4.9 to 5.6)	5.3	UDNR 1980
Beaver River, UT	Brown/Rainbow	(0.01 to 0.02)	.015	(1.8 to 5.8)	3.8	UDNR 1980
Calf Creek, UT	Brown	(0.04 to 0.15)	.085	(5.9 to 12.1)	9.0	UDNR 1980
Granite Creek, UT	Brook	0.04	—	2.9	—	UDNR 1980
Indian Creek, UT	Brown/Rainbow	(0.07 to 0.13)	.10	(8.3 to 13.4)	10.8	UDNR 1980
Little Creek, UT	Cutthroat/Rainbow	(0.03 to 0.04)	.035	(2.9 to 3.3)	3.1	UDNR 1980
Lost Creek, UT	Brown	0.02	—	7.8	—	UDNR 1980
Mill Creek, UT	Brown/Rainbow	0.01	—	1.5	—	UDNR 1980
North Fork North Creek, UT	Brown/Rainbow	0.05	—	5.8	—	UDNR 1980
Parawan Creek, UT	Brown/Rainbow	(0.06 to 0.12)	.09	(6.3 to 10.4)	8.4	UDNR 1980
Pine Creek, UT	Rainbow	(0.05 to 0.08)	.065	(5.3 to 6.4)	5.8	UDNR 1980
South Creek, UT	Brown/Cutthroat/Rainbow	0.09	—	9.8	—	UDNR 1980
Summit Creek, UT	Rainbow	(0.02 to 0.03)	.025	(1.0 to 6.2)	3.6	UDNR 1980
Urie Creek, UT	Rainbow	0.18	—	3.6	—	UDNR 1980

Table 7—Density and standing crop biomass of salmonids in selected streams within the Upper Gila Mountain ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Big Bonito Creek, AZ	Apache Trout	(0.31 to 0.40)	0.34	(10.8 to 14.6)	13.0	Rinne 1978
Big Dry Creek, NM	Brown/Gila Hybrid	(0.6 to 0.9)	.7	(23.0 to 23.1)	23.0	McHenry 1986
Iron Creek, NM	Gila	0.2	—	5.0	—	McHenry 1986
Iron Creek (S. Fk.), NM	Gila	0.2	—	4.8	—	McHenry 1986
Main Diamond Creek, NM	Gila	(0.4 to 0.6)	.5	(8.9 to 9.2)	9.1	McHenry 1986
McKenna Creek, NM	Gila	(0.1 to 0.2)	.13	2.6	—	McHenry 1986
McKnight Creek, NM	Gila	(0.3 to 1.1)	.5	(6.3 to 9.0)	7.7	McHenry 1986
South Diamond Creek, NM	Gila	(0.70 to 0.90)	.8	(7.3 to 20.0)	12.4	McHenry 1986
Spruce Creek, NM	Gila	0.21	—	4.8	—	McHenry 1986

Table 8—Descriptive statistics of biomass of trout by ecoregion

Ecoregion	Mean	Standard deviation	*n*
	g/m^2		
Pacific	2.17	1.97	54
Sierra	8.21	10.60	73
Columbia	3.80	4.44	42
Intermountain	4.03	3.88	22
Rocky Mountain	7.71	9.21	62
Colorado Plateau	6.15	3.12	15
Gila	9.15	6.29	9
Average	5.39	6.63	277

Table 9—Results of the Fisher's LSD test for differences between biomass of trout by ecoregion. The 95 percent confidence intervals (C.I.) were generated around the mean difference between ecoregions

Ecoregion	Lower C.I.	Mean difference	Upper C.I.
		g/m^2	
Rcky-Gila	−8.79	−2.38	4.02
Rcky-Sier	−6.47	−1.82	2.84
Rcky-Colo	−5.04	.62	6.28
Rcky-Intm	−2.18	3.13	8.43
Rcky-Colu	−1.52	3.44	8.40
Rcky-Paci	− .18	4.57	9.33
Gila-Sier	−4.51	.56	5.64
Gila-Colo	−3.01	3.00	9.01
Gila-Intm	− .16	5.51	11.19
Gila-Colu	.46	5.82	11.18*[1]
Gila-Paci	1.78	6.95	12.12*
Sier-Colo	−1.65	2.43	6.53
Sier-Intm	1.35	4.95	8.54*
Sier-Colu	2.19	5.26	8.32*
Sier-Paci	3.67	6.38	9.10*
Paci-Colo	−8.15	−3.95	.25
Paci-Intm	−5.15	−1.44	2.28
Paci-Colu	−4.34	−1.13	2.08
Colu-Colo	−7.26	−2.82	1.62
Colu-Intm	−4.29	− .31	3.67
Intm-Colo	−7.33	−2.51	2.31

[1] *Significant at 0.05 percent.

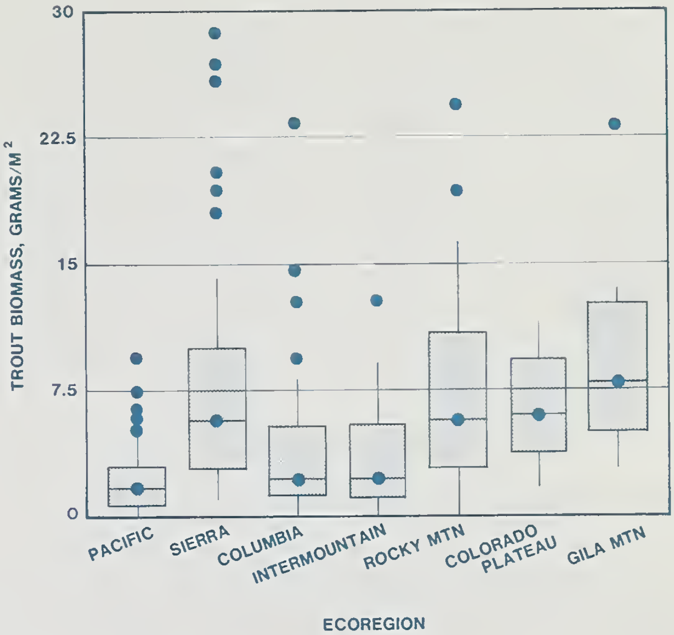

Figure 2—Box plots of trout biomass by ecoregion. Upper and lower sections of boxes represent 75th and 25th percentiles, respectively. White lines within boxes are the median, and circles are outlying data points.

Because of the skewed distribution of the data and apparent heterogeneity of variance, we felt medians were important descriptive statistics. Interestingly, highest median biomass was in the Gila Mountains (7.6 g/m^2), followed by the Colorado Plateau (5.9 g/m^2), Sierra Nevada (5.6 g/m^2), Rocky Mountains (5.4 g/m^2), Intermountain and Columbia (1.8 g/m^2), and Pacific regions (1.6 g/m^2). Box plots of biomass by ecoregion are depicted in figure 2.

In contrast to biomass, density of salmonids in the Western United States was less variable, exhibiting a narrow range of values. Density ranged from 0 to 4.2 fish/m^2 (tables 1-7) and averaged 0.25 fish/m^2 for all sites. The highest densities were in the Rocky Mountain ecoregion (0.55 fish/m^2), followed by the Gila Mountain (0.39 fish/m^2), Pacific (0.29 fish/m^2), Columbia (0.22 fish/m^2), Sierra Nevada (0.16 fish/m^2), Colorado Plateau (0.07 fish/m^2), and Intermountain (0.40 fish/m^2) ecoregions. Descriptive statistics for trout density by ecoregion are shown in table 10. Although the range of density values was far less than those observed for biomass, significant differences between regional trout density were observed (ANOVA F = 3.01). Individual paired *t*-tests (Fisher's LSD) are given in table 11 and show the unique differences between trout density in each region.

Analysis of medians through box plotting (fig. 3) confirms the narrow range of density values. Medians for all regions were all less than 0.4 fish/m^2, while box height was much less than observed in biomass box plots. Box height represents the spread or range of 50 percent of the data (data between 25th and 75th percentiles). Meaningful comparisons of trout densities were occluded because of smaller sample size and a plethora of measurement units. Additionally, we were unable to ascertain the contribution of juvenile fishes to density measures.

To explore the relationship between trout density and biomass, all data were analyzed both regionally and by pooling all paired data points. After reviewing several scatter plots, least squares linear regression was used with trout density as the independent variable and trout biomass as the dependent variable. Generally, density was not a significant factor in describing regional biomass trends (table 12). In three regions, the Gila Mountain (r^2 = 0.59), Sierra Nevada (r^2 = 0.28), and Columbia (r^2 = 0.17), density of trout contributed at least some information for explaining the variation in trout biomass. In the remaining regions, we concluded that trout density was not a significant factor in explaining trout biomass because the slope of the regression was not significantly different from zero at the 0.05 percent level.

Table 10—Descriptive statistics of density of trout by ecoregion

Ecoregion	Mean	Standard deviation	*n*
	Fish/m²		
Pacific	0.29	0.29	49
Sierra	.16	.17	61
Columbia	.22	.16	43
Intermountain	.04	.40	39
Rocky Mountain	.55	.67	18
Colorado Plateau	.07	1.12	15
Gila Mountain	.39	.24	9
All	.25	.51	234

Table 11—Results of the Fisher's LSD test for differences between biomass of trout by ecoregion. The 95 percent confidence intervals (C.I.) were generated around the mean difference between ecoregions

Ecoregion	Lower C.I.	Mean difference	Upper C.I.
		g/m²	
Rcky-Gila	−0.08	0.25	0.59
Rcky-Paci	.08	.34	.59*[1]
Rcky-Colu	.14	.41	.67*
Rcky-Intm	.18	.46	.75*
Rcky-Sier	.23	.47	.73*
Rcky-Colo	.20	.51	.81*
Gila-Paci	− .18	.09	.36
Gila-Colu	− .13	.15	.44
Gila-Intm	− .08	.21	.51
Gila-Sier	− .04	.22	.49
Gila-Colo	− .06	.26	.57
Paci-Colu	− .10	.06	.23
Paci-Intm	− .07	.12	.32
Paci-Sier	− .01	.13	.28
Paci-Colo	− .05	.16	.39
Colo-Intm	− .29	.06	.27
Colu-Sier	− .09	.07	.23
Colu-Colo	− .13	.10	.34
Intm-Sier	− .18	.01	.20
Intm-Colo	− .21	.04	.29
Sier-Colo	− .18	.03	.25

[1]*Significant at 0.05 percent.

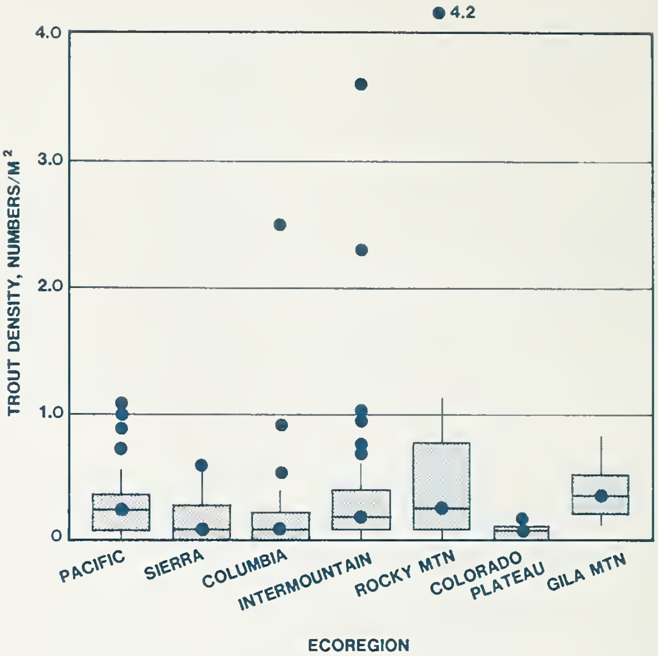

Figure 3—Box plots of trout density by ecoregion. Upper and lower sections of boxes represent 75th and 25th percentiles, respectively. White lines within boxes are the median, and circles are outlying points.

Table 12—Results of least squares linear regression analysis of trout biomass (*x*) and density (*y*)

Ecoregion	Equation	[1]r^2	*P*
Pacific	$y = 1.70 + 1.59\,(x)$	0.05	0.09
Sierra	$y = 2.39 + 35.63\,(x)$	.28	.001*[2]
Columbia	$y = 2.33 + 4.06\,(x)$	.17	.01*
Intermountain	$y = 2.64 + 5.46\,(x)$	.04	.34
Rocky Mountain	$y = 5.64 + 0.48\,(x)$	.01	.79
Colorado Plateau	$y = 5.07 + 7.60\,(x)$	.24	.06
Gila Mountain	$y = 1.09 + 20.25\,(x)$	.59	.01*
All	$y = 4.63 + 3.01\,(x)$	.02	.03

[1]r^2 = coefficient of determination.
[2]*Significant at 0.05 percent.

Analysis by species indicated small but significant differences in the level of density/biomass of different salmonids in the Western United States. Nine trout species—Apache, brook, brown, bull, cutthroat, Gila, golden, rainbow, and mixed (streams occupied by more than one species of trout)—were included in the analysis. Analysis of variance led us to reject the null hypothesis "no difference in biomass between species of trout in the Western United States" ($F = 2.28$, $p < 0.01$). Similarly, density was also found to be significantly different at the 0.01 percent level ($F = 2.42$). Results of the density/biomass species comparison using the Fisher's LSD test are provided in tables 13 and 14.

To assist biologists in planning and managing of fishery resources, we developed a series of biomass curves for each ecoregion (figs. 4-9) except Gila Mountain, which we omitted because of small sample size. Although certainly not all encompassing, these curves will allow biologists to compare a particular stream on a regional perspective. Thus, a biologist can ascertain the biomass of a stream and make inferences to its relative value as a fishery as compared to other streams within the same ecoregion. From a planning standpoint, such information is invaluable. However, other factors such as economics, esthetics, and sociological and political factors should also be considered before management decisions are made.

Table 13—Results of the Fisher's LSD test for differences between density of trout species in the Western United States. The 95 percent confidence intervals were generated around the mean difference between species

Species	Lower C.I.	Mean difference	Upper C.I.
		Fish/m²	
Brwn-Goln	−0.30	0.29	0.90
Brwn-Rain	.02	.34	.65*[1]
Brwn-Gila	− .05	.34	.74
Brwn-Apac	− .44	.36	1.17
Brwn-Cutt	.12	.41	.70*
Brwn-Brok	.15	.48	.80*
Brwn-Bull	.36	.44	1.25*
Brwn-Mixd	.26	.54	.82*
Goln-Rain	− .52	.04	.60
Goln-Gila	− .56	.04	.65
Goln-Apac	− .87	.06	.99
Goln-Cutt	− .43	.11	.66
Goln-Bull	− .78	.14	1.08
Goln-Brok	− .38	.18	.74
Goln-Mixd	− .30	.24	.78
Rain-Apac	− .75	.02	.81
Rain-Cutt	− .12	.07	.27
Rain-Bull	− .67	.11	.88
Rain-Brok	− .10	.14	.38
Rain-Mixd	.01	.21	.39*
Gila-Apac	− .79	.02	.83
Gila-Cutt	− .23	.07	.38
Gila-Bull	− .71	.10	.92
Gila-Brok	− .19	.13	.47
Gila-Mixd	− .09	.20	.50
Apac-Cutt	− .72	.05	.82
Apac-Bull	− .99	.08	1.15
Apac-Brok	− .66	.11	.89
Apac-Mixd	− .58	.17	.94
Cutt-Bull	− .74	.03	.80
Cutt-Brok	− .13	.06	.27
Cutt-Mixd	.00	.13	.26
Bull-Brok	− .74	.03	.81
Bull-Mixd	− .66	.09	.86
Brok-Mixd	− .12	.06	.25

[1] *Significant at 0.05 percent.

Table 14—Results of the Fisher's LSD test for differences between biomass of trout species in the Western United States. The 95 percent confidence intervals (C.I.) were generated around the mean difference between species

Species	Lower C.I.	Mean difference	Upper C.I.
		g/m²	
Brwn-Apac	−17.0	−1.45	14.11
Brwn-Goln	−8.05	3.55	15.15
Brwn-Mixd	− .59	4.81	10.22
Brwn-Gila	−2.67	4.92	12.52
Brwn-Rain	1.05	7.19	13.33*[1]
Brwn-Brok	2.19	8.37	14.56*
Brwn-Cutt	3.15	8.74	14.33*
Brwn-Bull	−6.56	9.05	24.62*
Goln-Apac	−22.9	−5.00	12.97
Goln-Mixd	−9.22	1.26	11.75
Goln-Gila	−10.4	1.37	13.13
Goln-Rain	−7.24	3.64	14.53
Goln-Brok	−6.08	4.82	15.73
Goln-Cutt	−5.38	5.19	15.77
Goln-Bull	−12.5	5.50	23.47
Rain-Apac	−23.7	−8.64	6.39
Rain-Goln	−14.5	−3.64	7.23
Rain-Mixd	−6.00	−2.38	1.23
Rain-Gila	−8.72	−2.27	4.17
Rain-Brok	−3.52	1.17	5.88
Rain-Cutt	−2.33	1.54	5.43
Rain-Bull	−13.2	1.85	16.89
Gila-Apac	−22.1	−6.37	9.32
Gila-Mixd	−5.86	− .11	5.64
Gila-Brok	−3.03	3.45	9.94
Gila-Cutt	−2.10	3.82	9.74
Gila-Bull	−11.5	4.13	19.82
Apac-Mixd	−8.49	6.26	21.01
Apac-Brok	−5.23	9.82	24.88
Apac-Cutt	−4.63	10.19	25.01*
Apac-Bull	−10.5	10.50	31.25*
Cutt-Mixd	−6.51	−3.93	1.36*
Cutt-Brok	−4.32	− .37	3.58
Cutt-Bull	−14.5	.31	15.13
Brok-Mixd	−7.25	−3.56	.13
Brok-Bull	−14.4	.67	15.73
Bull-Mixd	−18.9	−.31	14.51

[1] *Significant at 0.05 percent.

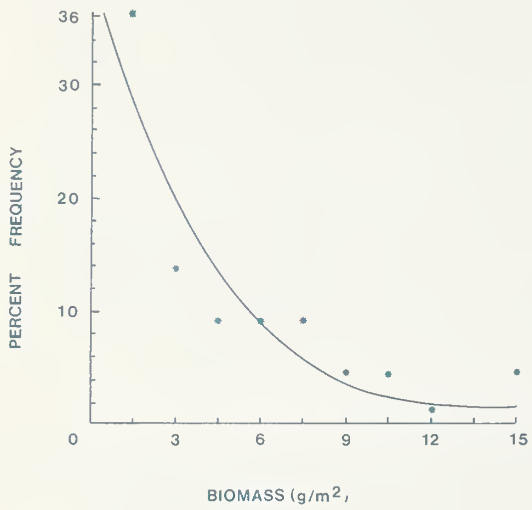

Figure 4—Trout biomass-frequency distribution curve for streams in the Intermountain Sagebrush ecoregion.

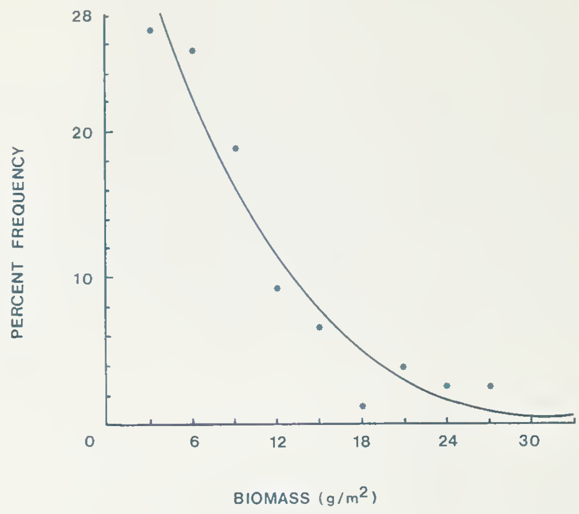

Figure 6—Trout biomass-frequency distribution curve for streams in the Sierra Nevada Forest ecoregion.

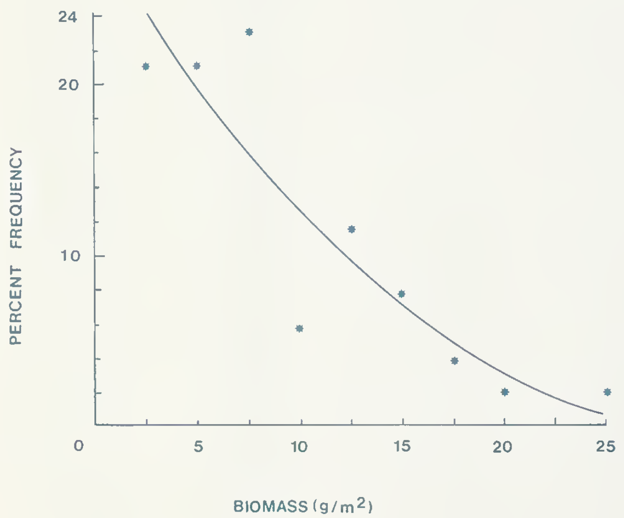

Figure 5—Trout biomass-frequency distribution curve for streams in the Rocky Mountain Forest ecoregion.

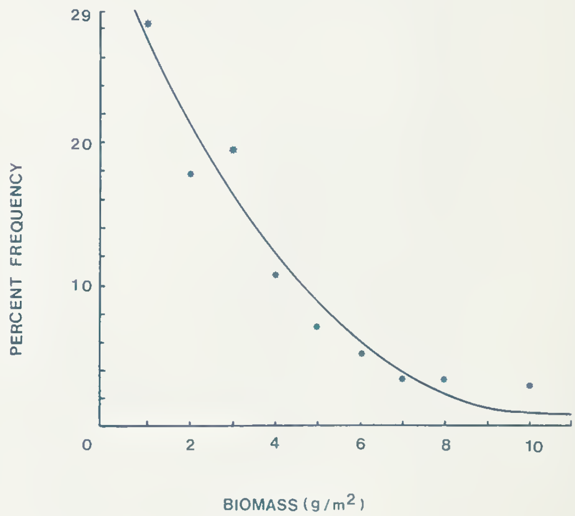

Figure 7—Trout biomass-frequency distribution curve for streams in the Pacific Forest ecoregion.

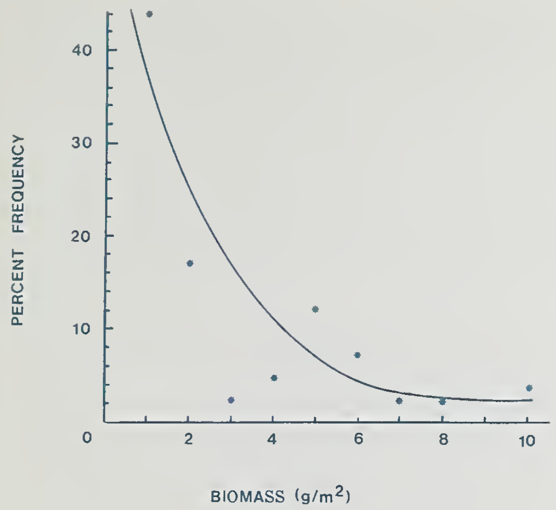

Figure 8—Trout biomass-frequency distribution curve for streams in the Colorado Plateau ecoregion.

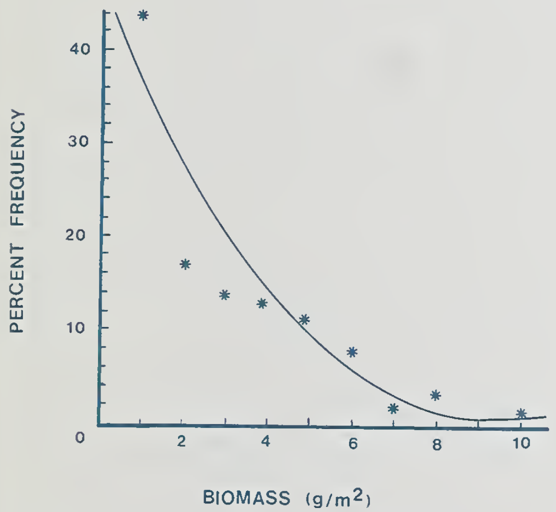

Figure 9—Trout biomass-frequency distribution curve for streams in the Columbia Forest ecoregion.

DISCUSSION

The data sets showed that significant interregional differences existed between the density and biomass of trout in the Western United States. Although it is difficult to speculate why these differences occurred without accompanying habitat and environmental data, several explanations are plausible. On the macro level, interregional differences between the biomass and density of trout populations are probably best explained by large shifts in patterns of general environmental conditions. Platts (1982) found that in the South Fork Salmon River, ID, geology, climate, and hydraulics interacted to influence fish population. Such reasoning reflects the current effort to build physical environment-fish population classification models (Frissel and others 1986; Lotspeich and Platts 1979).

Another possible explanation for the observed differences in trout populations is variations in microhabitat potential. Salmonid populations are limited both temporally and spatially (Hall and Knight 1981) by a variety of physical, chemical, and biological factors. Hynes (1972) determined that the most important abiotic factors controlling survival in fluvial fish habitats are water temperature, water velocity, escape cover, and discharge regime. Lewis (1969) and Rinne (1982) identified pool volume as significantly correlated to trout populations in Montana and New Mexico, respectively. Discharge was successfully used to explain the biomass of brook trout in Michigan (Latta 1965), Atlantic salmon in Maine (Havey and Davis 1970), and brown trout in Wisconsin (White 1975). A number of studies have identified cover as limiting to trout populations (Binns and Eiserman 1979; Hunt 1974; Wesche 1980). Other authors have discovered relationships between trout populations and depth (Stewart 1970), invertebrate biomass (Murphy 1979), and large organic debris (Sedell and others 1982). Results of these studies indicate that seldom does a single factor limit fish populations. Rather, it is a series of variables that combined operate to positively or negatively influence a population. While it is evident that a single factor such as flooding may temporarily limit a given population, it is the combination of environmental variables through time and space that determines the ultimate success or failure of a population.

Pooling all available data by species showed few significant trends. Density and biomass of brown trout were significantly greater than those of brook, bull, cutthroat, and rainbow trout. Whether or not this observation is attributable to the brown trout's aggressive behavior is speculative.

Streams occupied by multiple species of trout (sympatric) had densities and biomasses that were not significantly different from those streams occupied by single species (allopatric). These results indicate that various assemblages of salmonids may have an equal ability to occupy an available stream habitat. Although interspecific competition between species may determine the relative contributions of individual species to the composition of a population, it appears that regardless of species and in the absence of human perturbations, trout will occupy a habitat to its potential carrying capacity.

Trout density was generally not a significant factor in explaining regional biomass trends. These results were not particularly surprising because in most regions we had no idea of the contribution of juvenile age classes to the population estimates. Although juvenile fishes typically contribute only about 10 percent of the biomass by weight, their contribution to density measurements is usually far greater (Allen 1951). Additionally, because juvenile trout are subject to high mortality rates, thereby fluctuating greatly in abundance, it may not be possible to develop predictive equations concerning biomass and density. Further study is necessary to allow complete understanding of this relationship.

The development of regional biomass curves represents an important step for fisheries managers. By comparing a stream to other streams in a particular region, it will be possible to make inferences to that stream's productivity. If, for example, a stream in the Pacific Forest ecoregion had a biomass of 10.0 g/m^2, it would be important to give that stream special management considerations, as streams with that level of biomass occurred less than 10 percent of the time (fig. 7).

In conclusion, analysis of trout density and biomass for seven ecoregions of the Western United States indicates that regional differences are apparent. Although several reasons for these differences are identified (geoclimatic differences, microhabitat potential), the authors feel that without additional quantitative environmental and habitat data, development of cause-and-effect theories would be speculative. Rather, we would prefer to let biologists, intimately familiar with conditions in the respective ecoregions, draw their own conclusions. The authors plan to continue expanding the existing data base. Additional data will increase the reliability of the analysis and lead to greater confidence among relationships.

We feel that this document is important as background for management decisions. The identification and protection of high productivity stream systems are important in multiple-use Federal agencies. Similarly, enhancement of degraded streams is also critical. A regional perspective will allow managers to make better management decisions, benefitting both society and the environment.

REFERENCES

Allen, K. R. 1951. The Horokiwi stream: a study of a trout population. Bulletin Number 10. Wellington, New Zealand: New Zealand Department of Fisheries. 231 p.

Bailey, R. G. 1980. Description of the ecoregions of the United States. Misc. Publ. 1391. Washington, DC: U.S. Department of Agriculture, Forest Service. 13 p.

Binns, N. A.; Eiserman, F. M. 1979. Quantification of fluvial trout habitat in Wyoming. Transactions of the American Fisheries Society. 108(3): 215-228.

Burns, J. W. 1971. The carrying capacity for juvenile salmonids in some Northern California streams. California Fish and Game. 57: 44-57.

Chambers, T. M.; Cleveland, W. S.; Kleiver, B.; Tukey, P. A. 1983. Graphical methods for data analysis. Boston: Duxbury Press. 215 p.

Colorado Division of Wildlife. 1981. Colorado Fish. Res. Bull. 10. Denver, CO: Fisheries Research Section. 31 p.

Elser, E. A. 1968. Fish populations of a trout stream in relation to major habitat zones and channel alteration. Transactions of the American Fisheries Society. 97: 389-397.

Frissel, C. A.; Liss, W. J.; Warren, C. E.; Hurley, M. D. 1986. A hierarchical framework for stream habitat classification: viewing streams in a watershed context. Environmental Management. 10: 199-214.

Hall, J. D.; Lantz, R. L. 1969. Effects of logging on the habitat of coho salmon and cutthroat trout in coastal streams. In: Northcote, T. G., ed. Symposium on salmon and trout in streams. H. R. MacMillan Lectures in Fisheries. Vancouver, BC: University of British Columbia: 355-375.

Hall, J. D.; Knight, J. J. 1981. Natural variation in abundance of salmonid populations in streams and its implications for design of impact studies. EPA-600/53-81-021. Corvallis, OR: U.S. Environmental Protection Agency. 5 p.

Havey, K. A.; Davis, R. M. 1970. Factors influencing standing crops and survival of juvenile salmon at Barrows Stream, Maine. Transactions of the American Fisheries Society. 99: 297-311.

Heimer, J. T. 1979. Fish populations in the Sage Creek-Smokey Creek drainages, Caribou County, Idaho. Report to J. R. Simplot Co., Boise, ID. 46 p.

Holton, G. D. 1953. A trout population study on a small creek in Gallatin County, MT. Journal of Wildlife Management. 17: 62-82.

Hunt, R. L. 1974. Annual production by brook trout in Lawrence Creek during eleven successive years. Tech. Bull. 82. Madison, WI: Wisconsin Department of Natural Resources. 29 p.

Hynes, H. B. N. 1972. The ecology of running waters. Liverpool, England: Liverpool University Press. 555 p.

Johnson, D. B. 1985. A biological and physical inventory of Clear Creek, Orofino Creek, and the Potlatch River, tributary streams of the Clearwater River, Idaho. Portland, OR: U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. 292 p.

June, J. A. 1981. Life history and habitat utilization of cutthroat trout (*Salmo clarki*) in a headwater stream on the Olympic Peninsula, Washington. Seattle, WA: University of Washington. 117 p. Thesis.

Latta, W. C. 1965. Relationship of young-of-the-year trout to mature trout and groundwater. Transactions of the American Fisheries Society. 94: 32-39.

Leathe, S. A. 1980. Habitat utilization by westslope cutthroat and bull trout in the upper Flathead River basin, Montana. In: Western proceedings of the 60th annual conference of the Western Association of Fish and Wildlife Agencies; 1980 July 27-30; Kalispell, MT: 17-26.

Lestelle, L. C. 1978. The effects of forest debris removal on a population of resident cutthroat trout in a small headwater stream. Seattle, WA: University of Washington. 109 p. Thesis.

Lewis, S. L. 1969. Physical factors influencing fish populations in pools of a trout stream. Transactions of the American Fisheries Society. 98: 14-17.

Lotspeich, F. B.; Platts, W. S. 1979. An integrated land-aquatic classification system. North American Journal of Fisheries Management. 2: 138-149.

Martin, D. J.; Salo, E. O.; White, S. T.; June, J. A.; Foris, W. J.; Luchetti, G. L. 1981. The impacts of managed streamside timber removal on cutthroat trout and the stream ecosystem. Seattle, WA: University of Washington, Fisheries Research Institute. 131 p.

Mauser, G. A. 1972. Abundance and emigration of north Idaho cutthroat trout enclosed within sections of a tributary stream. Moscow, ID: University of Idaho. 86 p. Thesis.

McHenry, M. L. 1986. A test of the Habitat Quality Index in forested headwater streams of the Gila National Forest, New Mexico. Las Cruces, NM: New Mexico State University. 73 p. Thesis.

Moyle, P. B.; Vondracek, B. 1985. Persistence and structure of the fish assemblage in a small California stream. Ecology. 66(1): 1-13.

Murphy, M. L. 1979. Predator assemblages in old-growth and logged sections of small Cascade streams. Corvallis, OR: Oregon State University. 72 p. Thesis

Nehring, B. R. 1979. Evaluation of instream flow methods and determination of water quantity needs for streams in the State of Colorado. Report to U.S. Department of the Interior, U.S. Fish and Wildlife Service, Cooperative Instream Flow Group, Fort Collins, CO. 33 p.

Nehring, B. 1983. Approaches to special regulations management in fisheries in Colorado. In: Proceedings of the western 63d annual conference of the Western Association of Fish and Wildlife Agencies; 1983 July 11-14; Teton Village, WY: 62-70.

Needham, P. R.; Moffett, J. W.; Slater, D. W. 1945. Fluctuations in wild brown trout populations in Convict Creek, California. Journal of Wildlife Management. 9: 9-25.

Nevada Department of Wildlife. 1980. Stream inventory of the Bureau of Land Management's Wells Resource Area, Final Report, Contract #YA-512-CT9-121. Reno, NV: Nevada Department of Wildlife. 107 p.

Neve, L. C.; Moore, V. 1983. Population estimates and size regimes of cutthroat and brook trout in Diamond, Kendall, and Spring Creeks, Idaho. Northwest Science. 57(2): 85-90.

Nickelson, T. E.; Hafele, R. E. 1978. Streamflow requirements of salmonids. Annual Progress Report. Portland, OR: Oregon Department of Fish and Wildlife. 26 p.

Osborn, G. O. 1981. Effects of logging on cutthroat trout (*S. clarki*) in small headwater streams. Seattle, WA: University of Washington. 57 p. Thesis.

Ott, L. 1984. An introduction to statistical methods and analysis. Boston: Duxbury Press. 183 p.

Platts, W. S. 1982. Relationship among stream order, fish populations, and aquatic geomorphology in an Idaho river drainage. Fisheries. 4: 5-9.

Rabe, F. W.; Bauer, S. B.; Foresman, K. S. 1975. Challis Planning Unit stream survey. Unpublished report. Moscow, ID: University of Idaho. 59 p.

Remmick, R. 1983. A survey of native cutthroat populations in the Bridger-Teton National Forest. Fish Division Report. Cheyenne, WY: Wyoming Game and Fish Department. 168 p.

Rinne, J. W. 1978. Development of methods of population estimation and habitat evaluation for management of Arizona and Gila trouts. In: Moring, J. R., ed. Proceedings of the wild trout-catchable trout symposium; 1978 February 15-17; Eugene, OR: 113-125.

Rinne J. W. 1982. Movement, home range, and growth of a rare southwestern trout in improved and unimproved habitats. North American Journal of Fisheries Management. 2: 150-157.

SAS Institute. 1985. SAS/STAT guide for personal computers. Version 6 edition. Cary, NC: SAS Institute, Inc. 378 p.

Scarnecchia, D. L.; Bergeson, E. P. 1986. Production and habitat of threatened Greenback and Colorado River cutthroat trouts in Rocky Mountain headwater streams. Transactions of the American Fisheries Society. 115: 382-391.

Sedell, J. R.; Yuska, J. E.; Speaker, R. W. 1982. Habitats and salmonid distribution in pristine, sediment-rich river valley systems: South Fork Hoh and Queets River, Olympic National Park. In: Meehan, W. R.; Merrell, T. R.; Hanley, T. A., eds. Fish and wildlife relationships in old-growth forest: Proceedings of a symposium; 1982 April 12-15; Juneau, AK. Morehead City, NC: American Institute of Fishery Biologists: 33-46.

Sokal, R. R.; Rohlf, F. J. 1973. Introduction to biostatistics. San Francisco: W. H. Freeman and Company. 368 p.

Stewart, P. A. 1970. Physical factors influencing trout density in a small stream. Fort Collins, CO: Colorado State University. 201 p. Dissertation.

U.S. Department of Agriculture, Forest Service. 1985. White River Falls fish passage project, Tygh Valley, Oregon. Volume II: Appendix A Fisheries Habitat Inventory, Mt. Hood National Forest. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. 321 p.

Utah Division of Natural Resources. 1980. An inventory of streams flowing across lands administered by the Bureau of Land Management. Parts I through V: Richfield, Moab, Cedar City, Vernal, Salt Lake Districts. Salt Lake City, UT: Utah Division of Natural Resources. 417 p. Internal report.

Washington Department of Fisheries. 1984. Study of juvenile steelhead densities and biomass in the Wind River Area. Unpublished report on file at: Washington Department of Fisheries, Olympia, WA. 34 p.

Wesche, T. A. 1980. The WRRI trout cover rating method: development and application. Water Resour. Ser. 78. Laramie, WY: University of Wyoming, Water Resources Research Institute. 46 p.

White, R. J. 1975. Trout population responses to streamflow fluctuation and habitat management in Big Roche-a-Cri Creek, Wisconsin. Verhandlungen Internationale Vereinigung fur Theoretishce und Angewandte Limnologie. 19: 2469-2477.

U.S. GOVERNMENT PRINTING OFFICE: 1988—573-039/61,052 REGION NO. 8

Platts, William S.; McHenry, Michael L. 1988. Density and biomass of trout and char in western streams. Gen. Tech. Rep. INT-241. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 17 p.

Density and biomass of resident salmonids in 313 streams in the Western United States were analyzed for tendencies and significant differences. A regional perspective was used for analysis by dividing the 11 Western States into seven separate physiographic ecoregions. Trout density was less variable than trout biomass. Density ranged from 0 to 4.2 fish/m^2, and averaged 0.25 fish/m^2, while biomass varied between 0 and 81.9 g/m^2, and averaged 5.4 g/m^2. Generally, trout density was highest in the Rocky Mountain ecoregion, while trout biomass was greatest in the Sierra Nevada and Upper Gila Mountain ecoregions. The relationship between trout biomass and density was generally nonsignificant. Biomass data were used to develop a series of regional biomass-frequency curves for use in planning and management activities.

KEYWORDS: production, carrying capacity, salmonids, population estimates, ecoregion

INTERMOUNTAIN RESEARCH STATION

The Intermountain Research Station provides scientific knowledge and technology to improve management, protection, and use of the forests and rangelands of the Intermountain West. Research is designed to meet the needs of National Forest managers, Federal and State agencies, industry, academic institutions, public and private organizations, and individuals. Results of research are made available through publications, symposia, workshops, training sessions, and personal contacts.

The Intermountain Research Station territory includes Montana, Idaho, Utah, Nevada, and western Wyoming. Eighty-five percent of the lands in the Station area, about 231 million acres, are classified as forest or rangeland. They include grasslands, deserts, shrublands, alpine areas, and forests. They provide fiber for forest industries, minerals and fossil fuels for energy and industrial development, water for domestic and industrial consumption, forage for livestock and wildlife, and recreation opportunities for millions of visitors.

Several Station units conduct research in additional western States, or have missions that are national or international in scope.

Station laboratories are located in:

Boise, Idaho
Bozeman, Montana (in cooperation with Montana State University)
Logan, Utah (in cooperation with Utah State University)
Missoula, Montana (in cooperation with the University of Montana)
Moscow, Idaho (in cooperation with the University of Idaho)
Ogden, Utah
Provo, Utah (in cooperation with Brigham Young University)
Reno, Nevada (in cooperation with the University of Nevada)